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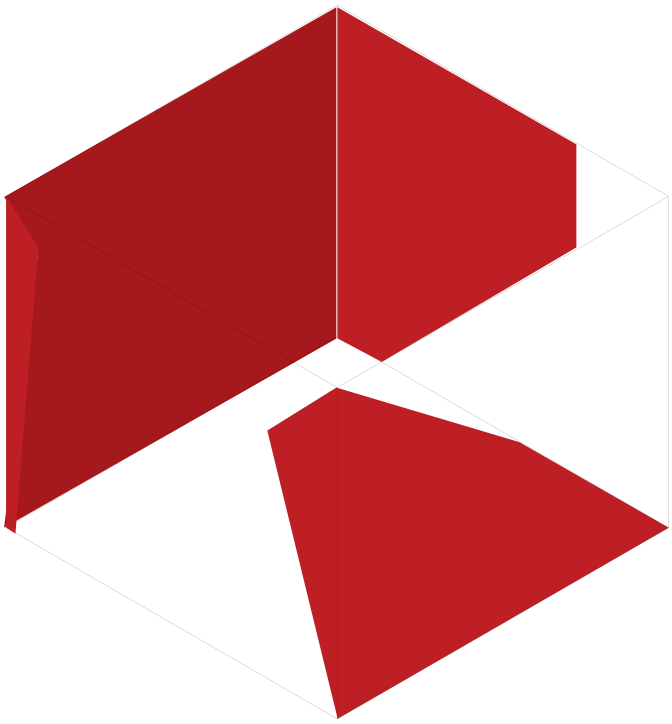

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Re / materialising Design Education Futures

Design futures—future designers: give me a 'T'?

Dr Katja Fleischmann

Abstract: Designers contribute increasingly to processes that drive economic, social and public innovations. To innovate successfully, cross-disciplinary teams are key. The kind of designer needed in these collaborative teams is described as T-shaped. The stem of the 'T' represents specialist knowledge of one or two areas; the horizontal bar stands for a broad understanding about other areas. While collaboration in various forms is the preferred working model for future designers, it is unclear how a T-shaped designer can be educated. This is particularly the case at undergraduate level where students are typically introduced to a wide range of subject areas. Therefore, the question investigated was: how can undergraduate design students learn the skills required for effective collaboration and thus develop a broad understanding of other disciplines while simultaneously continuing to develop their discipline-specific skills? A multidisciplinary learning and teaching model was trialled over a period of two years in an undergraduate digital media design degree. Quantitative and qualitative evidence in support of the development of T-shaped characteristics came from students and educators.

Keywords: multidisciplinary collaboration, T-shaped designer, undergraduate design education, POOL Model framework.

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Design futures—future designers: give me a ‘T’?

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1. Introduction

Disruptive shifts such as extreme longevity, increased global interconnectivity and social technologies driving new forms of production and value creation are forecasted to reshape our future economic and social landscape (Institute for the Future, 2011, p. 6). The way in which designers think has become increasingly valuable in processes that drive business, social and public innovations (e.g. Bason, 2010; Design Council, 2011; Vianna et al., 2012) and breaking out of ‘disciplinary cages’ has long been identified as pivotal to dealing with the complexity of problems arising through these shifts (e.g. Whyte & Bessant, 2007; Brennan, 2009; Ligon & Fong, 2009; Friedman, 2012; Davis, 2012). To innovate successfully, cross-disciplinary teams are key (Kelly, 2005; Buxton, 2009). Additionally, a ‘longing for transdisciplinary teams’ has more recently emerged (Brennan, 2009). However, as Buxton (2009) points out, useful guidance on how these collaborative processes work in practice dries up rather quickly. This is especially the case in design education which ‘has changed little for decades’ (Sless, 2012). Design education programs such as Graphic Design and Communication Design had, until the 1980s, clear directions and a similar purpose (Davis, 1998). They ‘shared many of the same tools, production standards, and methodologies as many other studio-oriented courses’ (Panning, 2005, p.15). The programs were print-focused, educating students as individual creators to design the media that dominated part of society at the time—namely print news, magazines, books and other printed material. Designers and design educators ‘were secure in the scope of their business [and] the body of knowledge necessary to practice graphic design was known’ (Davis, 1998 p. 25). The emergence of digital media during the 1990s brought a paradigm shift requiring new ways of thinking, the development of new design knowledge and new skills. To accommodate this change in design education, more subjects became cramped into an existing curriculum structure (e.g. web design, interactive media design) (Justice, 1998; Davis, 2011). Furthermore, the growing sophistication of digital technology has challenged the primary mode of practice as an individual designer (Wild, 1998). Digital media design projects often require specialised expertise beyond the capacity of any one individual (Kacmarek, 2001; Womack, 2005). It is unclear how students in undergraduate design programs can develop the required discipline-specific expertise whilst, simultaneously, the curriculum keeps expanding. Collaboration in various forms (inter-, multi-, trans-disciplinary) claimed to be the preferred working model for future designers (e.g. Bennett, 2009; Ligon & Fong, 2009; Davis, 2011; Hunt, 2011). This begs the questions: What kind of designer is needed? More specifically, what depth or breadth of knowledge does the industry require of a young designer or design graduate to successfully participate in a contemporary work environment? And, furthermore, how can they be educated?

2. The designer of the 21st century: What kind of designer is needed?

The awareness of the potential of design is changing, and so is the role of designers and the associated skill set that is required to function in today’s complex work environments. Some findings, for example from the Design Council (2006, 2010a), indicate the existence of a debate around what kind of designer is needed. In the context of solving future complex problems, the notion of the ‘specialist’ has become more formalised in design sector discourse, mainly through the design and innovation firm IDEO, which has for many years successfully established a multidisciplinary collaborative team culture. Tom Kelly (CEO of IDEO) identified a ‘T-shaped’ person as necessary in the innovation process. A T-shaped person, the cross pollinator, is a specialist with a set of broader skills or understanding

(Kelly, 2005). The stem of the ‘T’ represents specialist knowledge of one or two areas and the horizontal bar stands for a broad understanding and curiosity about other areas (Design Council, 2006) and an ability to collaborate across the disciplines (Harris, 2009; Hansen, 2010). (See Figure 1 below.) According to Leonard (1998, p. 75), ‘T-shaped skills surface anywhere problem solving is required across deep different functional knowledge bases or at the juncture of such deep knowledge with an application area’. Iansiti (1993 cited in Leonard, 1998, p. 75) provides an example: certain ceramic specialists ‘have a deep knowledge of a discipline like ceramic materials engineering…On the other hand [they] know how their discipline interacts with others such as polymer processing’.

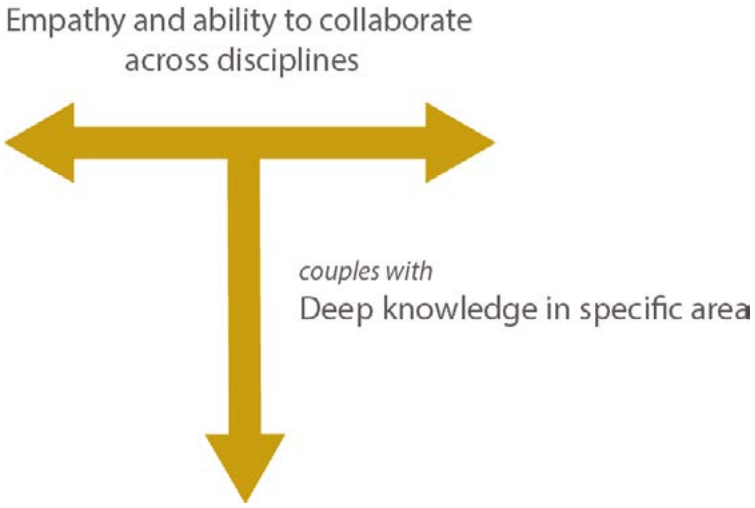

Figure 1. T-shaped person (based on Kelly, 2005; Harris, 2009).

While design consultancies like IDEO, Jump and Herbst LaZar Bell (HLB) ‘claim they are seeking these T-shaped individuals’ (Design Council, 2006, p. 6), others ‘look for the “hybrids” able to fully transcend several fields of discourse and practice, and work in innovative ways’ (Design Council, 2006, p. 6). The Design Council (2007) has highlighted the fact that it is the multidisciplinary business practice that has created the need for a hybrid ‘who can bridge the gap between the design world and the business world’ (p. 6). Robertus (cited in Design Council, 2007) in fact argues that hybrids ‘can work horizontally across the disciplines as motivators, co-ordinators and enablers’ (p. 6). However, Bruinsma (1998), Brown (cited in Design Council, 2006, p. 6) and the Design Council (2007) argue that in order for a team to be effective, both specialists with an understanding for other disciplines and hybrids are needed.

2.1 Industry expectations on digital media design graduates: Give me a ‘T’?

The profession of the digital media designer is inextricably linked to technological progress. However, the evolving nature of digital media technology has created a digital media design profession in a state of flux (Kerlow, 2001; Davis, 2005). Digital paradigms and potential new areas for designers to engage in (e.g. mobile devices, augmented reality) have been largely driven by an interdependent relationship between design and information technology (IT). The sophistication of the IT components driving many interactive digital media projects often requires specialised expertise beyond the capacity of any one individual (Kacmarek, 2001; Womack, 2005). The cast of contributors therefore extends beyond digital media and/or graphic design to include a diverse range of expertise such as information technology, information architecture, software engineering, research and theory, business strategy and

content production—as well as digital photography, illustration, 3D model making, musical composition, performance and other allied creative disciplines (Nelson, 2001). Specialists from other areas such as ‘communications theory…including semiotics, but also cognitive and perceptual psychology and strategies from the social sciences and cultural anthropology’ (McCoy, 1998) are also often involved in the development of interactive digital media design solutions.

There is no clear evidence that the digital media design industry specifically prefers a hybrid design graduate. On the contrary, there is an identifiable trend to suggest that the T-shaped person would be more easily employed. Because design is often discussed in a broad and inclusive way, a study was conducted that specifically explored employers’ expectations of design graduates in the digital media design industry (Fleischmann, 2010). This study revealed that design graduates need to have raw talent, creativity, excellent design skills and uniqueness or ‘something special’. Furthermore, skills broadly defined as teamwork and communication skills, as well as technical skills, are essential to gain and keep employment in the digital media design industry. Descriptions of the discipline-specific skills and attributes employers regarded as being the most important are presented in Table 1. An analysis of the type of expertise profile given by the employer is given in the third column of this table using the following descriptions:

- T-shaped; a specialist with a set of broader skills or understanding;
- Specialist; a person with deep discipline-specific skills in one narrow area; and
- Hybrid; a person who works horizontally across the disciplines, also known as a generalist.

Business	Comments to describe the preferred digital media design graduate profile	Implied expertise profile of graduate
B1	…we look for a person who’s multi-skilled, but they need to be good at what they’re specialising in.	Specialist with an understanding of, or skills in, other areas: T-shaped
B2	If we’re looking for a design person, he has to be an absolutely brilliant top designer. If he’s good at HTML, that’s a bonus but not as important.	Specialist with T-shaped a bonus
B3	Having IT and design students learn about their area and work together is more beneficial than trying to teach everybody the whole lot. … Some of our designers do code CSS at least …but I’d rather have someone who was really good at design than someone that knew a bit of design.	Specialist with an understanding of, or skills in, other areas: T-shaped
B4	A designer would go mad if all they’re doing is HTML and getting no creative chances. So we do have specialists in every area but they don’t work solely in that area because we try and get a variety.	Specialist with skills in other areas: T-shaped

B5	…we do have specialists. If it's a priority project, we know that Peter is going to do the cut up and CSS and HTML and that's a specialty. If it's a special point of sale stuff, we know that Martin will do that. However, we definitely don't like boxing people up because, particularly in this industry, that's always changing and always fluid…	Specialist with the opportunity to work in other areas: T-shaped implied
B6	They have to know what they want to specialise in, because although we allow our staff to do a wide range of things, they still have their specialty.	Specialist with the opportunity to work in other areas: T-shaped
B7	In this industry, it's more like you're a coder and you're a developer or you're creative and you're a graphic designer.	Specialist
B8	I think it's hugely beneficial to have someone who is great at development or great at design but then also has that other side as well.	Specialist with an understanding of other areas: T-shaped
B9	The ideal designer needs to be a video director, a video producer, a web designer, a developer, understanding print and pre-press, knowing how to design for magazines and knowing how to do the entire offline range.	Hybrid (generalist)

Table 1. Type of digital media design graduate preferred by Australian metropolitan-based employers.

Although Table 1 presents a relatively small number of employers' views, the majority of these refer to the possibility and/or requirement of working in other areas or having an understanding of other disciplines. Hence, Table 1 suggests, in accordance with the literature, that digital media design graduates are expected to have a depth of knowledge in their core discipline with a breadth of understanding of other disciplines, thus reflecting the T-shaped person described by Kelly (2005), the Design Council (2006), and Bessant and Whyte (2007) as the type of designer needed in the digital media design industry.

2.2 Educating the future designer?

Initiatives in re-designing existing curricula or formulating new programmes are usually part of the wider discourse about the kind of designer to be educated. Bhana (2010) argues that for design education, 'the question between specialised disciplines versus a more generalised interdisciplinary approach remains an inherent debate open for discussion' (p. 4). Responding to the ongoing developments in the digital technology and design sector has predominantly driven curriculum changes in design education. Davis (2011) argues: 'In recent decades, design schools have added content to full programmes of study in a curriculum-by-accrual attempt to respond to new practices and technologies' (p. 74). New subject areas became 'squeezed' into the design curriculum (Justice, 1998, p. 53). Lehrer (2005) criticises the approach, saying that in his view 'a more expansive approach…can foster dilettantism' (p. 80).

While knowledge areas keep expanding, simultaneously projects or problems are growing more complex and require discipline-specific knowledge and skills in a variety of areas for design projects to be of contemporary standard (in particular in interactive digital media

design) or to display a degree of innovation. This can be problematic for students. The extensive use of hard- and software and the time it takes to acquire technical skills (Heller, 2005) is one challenge for students to master. Another one presents itself through information technology (scripting and programming) which is a component of many design projects such as websites, games or mobile device applications. As a consequence, design students can be overwhelmed with the amount of technical and technological skills they have to comprehend before they are able to start designing (Maeda, 2002). This is especially the case given 'design students predominantly see themselves as visually and creatively minded people rather than "scientifically" minded' (Amiri, 2011, p. 201). Higgins (2008) argues in this context that the challenge persists in that the 'single largest issue of undergraduate design programs is that there simply is not enough time to teach everything necessary for students to graduate with the knowledge and skills of a well-rounded designer' (p. 3).

Recently, a new perspective has appeared which describes 'graduates who have cultivated breadth as well as depth' (Longbottom et al., 2007, p. 5). This ultimately describes the T-shaped designer who is required in the contemporary work environment. Hunt (2011, p. 87) sees these future graduates as 'both solidly specialised and flexibly generalised' which he also describes as a 'nearly impossible balancing act' for design education. Friedman (2012) also refers to a T-shaped graduate when arguing recently that design graduates need two kinds of education: 'One is specialty training in the advanced skills of a specific design practice. The other is a broad training that involves the kinds of thinking and knowledge designers need for a wide range of professional engagements' (p. 145).

Efforts to educate the T-shaped design graduate exist but tend to occur in newly founded programmes and at postgraduate level (e.g. Northumbria University: Master in Multidisciplinary Design Innovation; Stanford University: d.school supplementary Master certificate). Programmes that aim to create T-shaped designers appear to be less common in undergraduate design education. Design programs at undergraduate level tend to follow the interdisciplinary approach where design students are exposed to a wide range of subject areas within a degree (e.g. At Penn State University, design students have a common first year across various disciplines; and in the Interactive Media Design programme at Yildiz Technical University in Istanbul, students study design, sound and IT within one degree) (Özcan & Akarun, 2002). While these interdisciplinary approaches might allow students to address complex topics and 'draw on the disciplines with the goal of integrating their insights to construct a more comprehensive understanding' (Repko, 2011, p. 16), it is unclear how each discipline can simultaneously develop discipline-specific expertise in such setting.

Although publications and research on alternative approaches to design education have recently increased, there is a lack of published data measuring the impact and efficiency of these approaches (Design Council, 2010b). It is therefore difficult to establish whether the intended aims of new programmes are achieved and whether, for example, a certain approach is more suitable for undergraduate or postgraduate students. It is unclear whether it is even possible to educate a T-shaped design student at an undergraduate level. Therefore, the question investigated was: how can undergraduate design students become T-shaped and hence develop a broad understanding of other disciplines, while simultaneously continuing to develop their discipline-specific skills?

3. The POOL Model framework and its implementation

An alternative learning and teaching model was developed in order to facilitate the education of the T-shaped design student at undergraduate level. The POOL Model framework is based on multidisciplinary collaboration in which several disciplines cooperate but remain unchanged (Design Council, 2010b). The POOL Model framework consists of a teaching pool and a learning pool containing educators or students from diverse but connected disciplines. In the teaching pool, educators work collaboratively to define a project or problem context and create a learning environment for students to develop the project or respond to the problem in multidisciplinary teams. People external to the university are included in the teaching pool, such as industry professionals and the community in the capacity of clients, advisors, experts or sponsors.

In the *learning pool*, students from different disciplines form teams to solve a problem or produce a project collaboratively. The composition of the team will depend upon the presented problem or project. It is intended that while working in these collaborative multidisciplinary teams, a student will be able to gain insights into, and develop an understanding of, other disciplines. Each student will also have additional time to concentrate upon discipline-specific skill development and challenges within his/her multidisciplinary team while experiencing a more holistic and efficient way to approach complex projects or problems. Figure 2 provides a graphical illustration of the POOL Model framework.

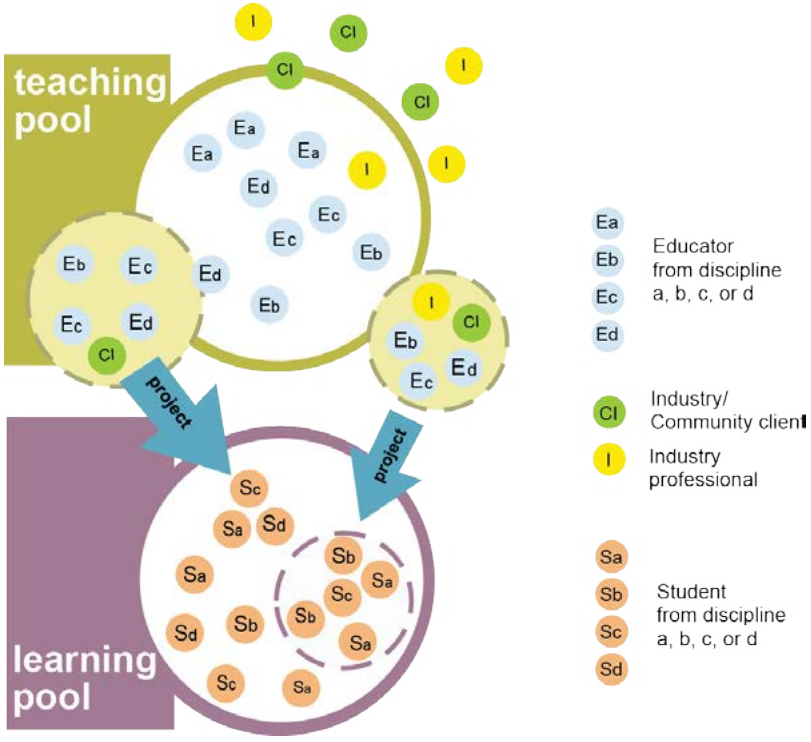

Figure 2. The POOL Model framework: an alternative learning and teaching approach for digital media design education.

3.1. Implementation and evaluation of effectiveness of framework

The POOL Model framework was implemented in three subjects in the curriculum of the digital media design major in the Bachelor of New Media Arts degree. Collaborations across other schools at the university, in particular with the Schools of Business, Information Technology and Journalism, were formalised to facilitate the formation of meaningful collaborations across disciplines. Subsequently, the following subjects were offered jointly: Introduction to Web Design (Design) and Web Programming (IT) (referred to as Web 1), Interactive Media Design (Design) and Internet Technologies (IT) (referred to as Web 2) and Creative Exchange (Creative Arts) and Project Management (IT) (referred to as CXC). This study reports on six subject trials, with the same three subjects conducted in Trial A and repeated in Trial B. Each subject involves three hours of contact time per academic week (total of 39 hours over the 13-week semester).

Weekly contact time is typically structured around a one-hour lecture and a two-hour practical delivered in a computer lab. Students are expected to study and undertake

self-directed work for an additional seven hours per subject per week during the semester. All three subjects were project-based and increased in level of complexity from 2nd to 3rd year; Web 1 (a 2nd year introductory web design subject), Web 2 (a 3rd year advanced interactive media design subject) and CXC (a 3rd year capstone subject which required the production of a major creative project or large scale published work). Table 2 provides details of student numbers, disciplines involved and project/problems given in the trials, feedback mechanisms applied and response rates. Details on the structure of classes, how teamwork and collaboration was managed within the framework, and how each discipline was assessed, hence how the POOL Model framework functions on a pragmatic level can be found in Fleischmann (2013) and also in Fleischmann (2012), Fleischmann and Hutchison (2012).

Subject trial Study level (no) Students' disciplines (no)	Feedback mechanism Student discipline	No of student feedback participants	Response rate (%)
Trial A			
Web 1 2nd year students (57) digital media design (34) information technology (23)	Online questionnaire at the end of project - digital media design	20	59
	Focus group interviews at the end of project - all disciplines	42 students (11 teams)	74
Web 2 3rd year students (51) digital media design (31) information technology (20)	Online questionnaire at the end of project - digital media design	28	90
	Focus group interviews at the end of project - all disciplines	48 students (8 teams)	94
CXC 3rd year students (48) digital media design (18) digital imaging (10) digital visual arts (4) performance (2) digital sound (8) information technology (6)	Online questionnaire at the end of project - digital media design	29*	97
	Focus group interviews at the end of project - all disciplines	44 students (13 teams)	92

Trial B			
Web 1 2nd year students (103) digital media design (51) information technology (43) multimedia journalism (8) business (1)	Online questionnaire at the end of project - digital media design	32	63
	Focus group interviews at the end of project - all disciplines	95 students (20 teams)	92
Web 2 3rd year students (50) digital media design (20) information technology (30)	Online questionnaire at the end of project - digital media design	18	90
	Focus group interviews at the end of project - all disciplines	48 students (9 teams)	96
CXC 3rd year students (50) digital media design (15) digital imaging (13) digital visual arts (8) performance (1) digital sound (4) information technology (3) business (2) education (4)	Online questionnaire at the end of project - digital media design	22*	79
	Focus group interviews at the end of project - all disciplines	45 students (11 teams)	90
* includes students with double major, e.g. digital media design and digital imaging			
Projects			
Web 1	Develop and design website for industry client		
Web 2	Develop and design online shop to sell fictional products		
CXC	Various large-scale projects, e.g. develop and design multiplayer game, multimedia exhibition, application for mobile device, design fashion magazine		

Table 2. Trial details for student participants in Trial A and Trial B.

In the teaching pool, fifteen educators from ten different disciplines were involved in delivering content and guiding project development processes in each trial. Twenty-one of the twenty-five educators (84%) agreed to participate in face-to-face interviews at the end of the subject trials.

4. Theoretical framework and research design

Because the research question does 'not sit comfortably within a wholly quantitative or qualitative approach to design and methodology' (Armitage, 2007, p. 3), this study is framed by a pragmatic approach or 'third way' of research (Creswell, 2003; Johnson and Onwuegbuzie, 2004; Morgan, 2007; Armitage, 2007; Greene, 2008; Teddlie & Tashakkori, 2009). The research question revealed that there were two main stakeholder groups: stu-

dents and educators. Collecting data from these groups would provide two perspectives on the researched issues and enable triangulation, or 'comparisons of multiple data sources' (Teddlie & Tashakkori, 2009, p. 27). This would allow validation of the research findings and provide a more complete picture of the problem under investigation (Teddlie & Tashakkori, 2009). A parallel mixed design (a single-phase design), in which quantitative and qualitative methods were implemented within the same timeframe (parallel) or with slight overlaps, was deemed the most practical approach for this research study, given the nature of the research context (class teaching and settings, time frames and time constraints, for example). Importantly, this mixed-methods research design would allow the comparison, validation, confirmation, or corroboration of quantitative results with qualitative findings (Creswell & Plano-Clark, 2007; Teddlie & Tashakkori, 2009).

At the end of each trial, students were asked to complete an online questionnaire which consisted of open- and closed-ended questions. For quantitative data obtained using online questionnaires, the web survey provider SurveyMonkey delivered basic statistical data, including the tally of response totals, percentages, and response counts. Student teams were also asked to participate in group interviews. Qualitative data (responses from online questionnaires and interviews) were analysed using the software NVivo—a qualitative data analysis programme. Broad coding themes existed initially (e.g. 'benefits' and 'challenges' of collaboration); however, the majority of themes were left to emerge during analysis. A conversion method, also referred to as data transformation (Tashakkori & Teddlie, 2003), was applied to qualitative data; that is through counting responses that mention a certain quality, category or theme. Through quantifying qualitative data, quantitative principle could be applied: 'the more data there are for a particular category, the stronger is the proof of that category' (Thody, 2006, p. 110).

5. Intended outcome 1: digital media design students continue to develop discipline-specific skills and knowledge

5.1. Student reflections

Table 3 presents digital media design students' reflections on the extent to which they were able to develop discipline-specific skills while engaging in the multidisciplinary teamwork process.

Question	Answer	Web 1 A	Web 1 B	Web 2 A	Web 2 B	CXC A	CXC B	Total no of responses	Total %
Do you feel that you could explore and concentrate on your area of expertise while being part of the multidisciplinary team?	Yes	90% (18)	78% (25)	61% (17)	78% (14)	83% (24)	77% (17)	115	77.2
	No	10% (2)	22% (7)	39% (11)	22% (4)	17% (5)	23% (5)	34	22.8
Total no of participants, n=		20	32	28	18	29	22	149	100

Table 3. Digital media design students' reflections on the extent to which they were able to develop discipline-specific skills.

While the findings are positive, it is notable that a percentage of digital media design students (22.8%) argued that they were unable to specifically develop their design skills. For students who felt they were able to develop in their specific discipline while participating in the multidisciplinary team process (115 of 149 digital media design students, 77.2%), their reasons were explored in greater depth. Table 4 presents the relevant data and shows the themes that emerged in questionnaires and focus group interviews, the number of times these were referenced by digital media design students (DMD) and those of other disciplines (Others), as well as exemplar quotes from digital media design students to add richness to the data.

Key benefits Questionnaires	No of references in questionnaires	Key benefits Focus group interviews extending/confirming view	No of references in focus group interviews		Example of typical comment by digital media design students
	DMD*		DMD	Oth-ers**	
Multidisciplinarity in teams allowed me to concentrate on my area of expertise	16	Focus on what you were good at and had someone else focus on other areas	26	21	It's good that you get to focus on what you do best, while someone else sorts out the things that you're not so good at. (Web 2 B)
Each student was responsible for a different part of the project	12	Focus on your own area and you did not have to learn about every single aspect of the project or be the Jack of all trades	9	2	It is good to have a group where everyone is good at what they do, and we can just focus on our own thing more, rather than having to do everything ourselves. This way we can just focus on design and we know everyone else is going to get the other things done. (Web 2 A)
Others helped out with their exper-tise/ I didn't have to worry about other disciplines	10	Focus on your own area and you did not have to worry about other areas	9	5	wIt was good that we [design students] solidly work on the design; we didn't have to worry about IT. Unlike when we made a website last year where we had to learn the IT stuff as well… I don't think we will program websites outside of Uni; we will just do the design. (Web 2 A)
I could concen-trate on my area of expertise and explore new or specific areas within design	10	Focus on your own discipline and spend more time on your own area (create better results)	20	11	We can concentrate on areas we are good at, and have experience in, which is good because we have more time to do those bits better and other people can do their stuff. (Web 1 A)
Total no of references	48		64	39	
* DMD=digital media design students; ** Others = students from disciplines other than digital media design					

Table 4. Coded themes from questionnaires and focus group interviews that evidence students were able to continue to develop discipline-specific skills and knowledge.

The findings in Table 4 provide rich evidence in support of the fact that students were able to continue to develop their discipline-specific skills, due to:

- the complementary skill sets in teams; and
- each discipline being responsible for the area of expertise they contributed to the overall project.

5.2. Educator reflections

Table 5 presents the perspectives of the 21 educators on the extent to which students were able to develop discipline-specific skills while simultaneously engaging in the multidisciplinary teamwork process. Where educators involved argued that the outcome was achieved, this is indicated by a 'Y' (Yes). The number in brackets represents those who supported the outcome if more than one educator provided feedback in the subject trials. One exemplar quote reflecting the identified benefits is presented in the last column.

Key benefits	Stated as an outcome in the interviews (no. of educators if more than one)			Exemplar comment in support of the intended benefit and outcome
		Trial A	Trial B	
Specialise / focus on area of expertise	Web 1	Y	Y	Almost all current websites have clear design and IT areas, and our project had enough scope and enough areas for each person to pick their role and work in that role with others. That worked well. (Trial A)
	Web 2	Y	Y (2)	…. I'd say they spent about 40% on developing their interface designs or a database and scripting the backend functionalities, and then 40% was in the group work… (Trial A)
	CXC	Y (6)	Y (4)	What was good was in all of the groups, people tended to fall naturally into particular roles. … I think all of them found out where they wanted to be ... So the people who wanted to be managers found out they wanted to be managers. The people who found out they were more interested in some of the artistic activities were going to try and focus on that. (Trial A)
No of educators, n=	15			

Table 5. Educators' reflections on the extent to which students were able to develop discipline-specific skills and knowledge.

The majority of educators (15 of 21 across the six subject trials) specifically stated that students were able to concentrate on their own area of expertise; however, it is interesting that the reflections are less rich and detailed than those of digital media design students, arguably due to educators observing the students and not being directly involved in the teamwork themselves. Alternatively, it may be that educators simply accepted this as a reality and did not feel the need to justify or explain the issue—which would explain why six of the 21

educators did not reflect on this during the interview. Furthermore, it should be noted that no specific question inquired about the development of students' discipline-specific skills during the interview, making it even more significant that numerous educators reflected on it.

6. Intended outcome 2: digital media design students gain insights into the ways in which different disciplines work and practice

Diverse disciplines have different ways of working which may differ greatly from digital media design. In order for digital media designers to effectively collaborate with other disciplines the development of an understanding of these differences is important. Perspectives on the extent to which this understanding was developed are presented.

6.1. Student reflections

Table 6 presents digital media design students' reflections on whether they were able to gain insights into areas other than their own during the multidisciplinary teamwork process.

Question	Answer	Web 1 A	Web 1 B	Web 2 A	Web 2 B	CXC A	CXC B	Total no of responses	Total %
While working on this project, did you get any insight into areas other than your own area of expertise?	Yes	70% (14)	63% (20)	89% (25)	89% (16)	86% (25)	91% (20)	120	80.5
	No	30.0% (6)	37% (12)	11% (3)	11% (2)	14% (4)	9% (2)	120	19.5
No of participants, n=		20	32	28	18	29	22	120	100

Table 6. Digital media design students' reflections on the development of insights into disciplines beyond their own.

Overall, the result is positive, although some students argued that their learning was limited to the design discipline (29 of 149 digital media design students). The data also reveal a higher percentage of such students in the subject Web 1, which is where formal multidisciplinary collaboration was introduced for the first time. Encouragingly, digital media design students' engagement in the process over time became more positive, evidenced by the increase in the number of students who were able to gain insights into other disciplines in their 3rd year (Table 6, Web 2 A, Web 2B, CXC A, CXC B) once they had an initial experience of this framework.

In order to further show how students gained insight into the ways in which different disciplines work and practice, four main themes emerged from the coding of focus group interviews—in which students reflected on how the project development process differed from a single discipline project. These are shown in Table 7.

Key benefits	No of references in focus group interviews		It is good to gain experience into what the other side is doing, so that in the future you can work with other disciplines. (Web 1 A)
	DMD*	Others**	
Understand other discipline	35	17	It is good to gain experience into what the other side is doing, so that in the future you can work with other disciplines. (Web 1 A)
Learn from or about other discipline	28	20	I think you learn a bit more about the other side and what it is capable of. Sometimes as designers we have all these big ideas, and may not realise that we can't actually do that. So you learn a bit more about each other and get a better idea of what is possible... (Web 2 A)
See things from a different perspective	20	13	Different disciplines focus on different areas, like the IT guys focus on ease of use of the website, an aspect I didn't exactly look at... It extends your knowledge, gives you options you wouldn't have had before, and you get to see things from a different perspective. (Web 1 B)
Appreciate the other discipline	19	19	It was good to see what the other side does; for example, what the IT part of the job involves and how much time and effort it takes for them to finish. (Web 1 A)
Total no of references	102	69	
* DMD=digital media design students; ** Others = students from disciplines other than digital media design			

Table 7. Coded themes from student focus group interviews that evidence the gaining of insights into the ways in which different disciplines work and practice.

6.2. Educator reflections

Table 8 presents the three key themes that emerged from the coding of interviews (21) during which educators reflected on whether they believed students gained insights into other disciplines.

Key benefits	Stated as an outcome in interviews (no of educators if more than one)			Exemplar comment in support of the intended benefit and outcome
		Trial A	Trial B	
Understand other discipline	Web 1	Y	Y	The most positive aspect was that IT students see the design students' work, and vice versa. (Trial A)
	Web 2	Y	Y (2)	Students have a better idea of how to understand, or at least have some empathy for, a different set of expectations. (Trial B)
	CXC	Y (6)	Y (7)	It's important to understand that there's actually a whole lot of deeper embedded learning in just seeing how someone else does something outside of their own area. (Trial A)

No of educators, n=	18			
Appreciate other discipline	Web 1	Y	Y	Both [IT and digital media design students] actually learned what other people do and valued it. (Trial A)
	Web 2	Y	Y (2)	I got the impression that once the design students were partnered up with the IT people there was this sense of relief, this ‘Ah, I don’t have to worry about this super technical action scripting stuff.’ They appreciated the luxury of working with an IT person...and just being designers. (Trial B)
	CXC	Y (6)	Y (5)	In the process of working with others…you had a sound person working with an image person, exploring those relationships within the process. Clearly, students learn to appreciate the other areas. (Trial B)
No of educators, n=	16			
Learn from other discipline	Web 1	Y	Y	… for an IT student to learn design from a design student is quite valid. You hope that the design students are doing better design work than the IT students, and so that pulls the IT students up in that area. I think the design students learned from the IT students as well. (Trial A)
	Web 2	Y	Y	Students rarely move outside of their own circle … and they pretty much don’t expect to pick up anything from outside that. But I think they did learn, although I don’t know how to quantitate this. (Trial B)
	CXC	Y (2)	Y	Students have learned a lot about their own disciplines and other disciplines. …having people talk to you…, suggest things, ask questions, would make each individual student think more critically about their own individual skill set and also content that others have produced. (Trial A)
No of educators, n=	7			

Table 8. Educators’ reflections on the extent to which students gained insights into the ways in which different disciplines work.

It is positive that across all subject trials educators identified that students gained an insight into how different disciplines work. The majority of educators stated that students learned to understand other disciplines (18 of 21 educators) and appreciate other disciplines (16 of 21 educators). Some educators (7) reflected that they also learned from other

disciplines. Although some did not specifically refer to this outcome, none of them argued that it was not achieved.

7. Factors inhibiting the achievement of intended outcomes

While the majority of digital media design students reflected positively on the opportunity to achieve the intended outcomes, some stated they were unable to:

- Continue to develop discipline-specific skills and knowledge (n=34, 23%).
- Gain insights into the ways in which different disciplines work and practice (n=29, 19%).

Perspectives from both stakeholder groups are therefore presented to identify the influencing factors.

7.1. Student reflections on the factors inhibiting the achievement of intended outcomes

Within questionnaires some students identified which factors they felt prevented them from achieving the intended learning outcomes. From the 67 relevant comments the following challenges were identified:

- Different work ethic resulting in unequal workloads (33)
- Communication problems between team members (26)
- Less skilled team members and therefore a student had to take over another discipline's part (5)
- Problems between designers with clashing views on design (3)

7.2. Educator reflections on the factors inhibiting the achievement of intended outcomes

Educators identified similar challenges. Educators involved in Web 1 and Web 2 referred to some students 'not pulling their weight' (Educator, Web 1 A). Educators who provided feedback on the CXC subject trials made similar observations, while one also referred to 'students taking on projects that were too large, weak team members, interpersonal issues, some supervisors were hard to get time with' (Educator, CXC A). The educator in Web 1 summed it up as follows: 'You're dealing with students. Some of them will choose to do the minimum' (Trial A). Overall, educators only identified a small number of challenges. However, some educators pointed towards the positives that can emerge from experiencing challenges: 'Of course, there is the age-old problem of some people contributing more, some contributing less. They do not necessarily like that experience, but nevertheless the students benefit from that experience' (Educator, CXC B).

8. Discussion and concluding remarks

The feedback presented suggests that the POOL Model framework provides the opportunity for digital media design students to explore their own discipline—thereby enabling them to continue to develop discipline-specific skills and knowledge while participating in multidisciplinary collaborative teamwork. While, in some situations, teamwork problems prevented this from occurring, one positive observation was that the framework allowed the majority of digital media design students to deepen their discipline knowledge and skills because each team member was responsible for a different part of the project. This allowed digital media design students to focus on their area of expertise, engage more deeply in design matters, or explore other related areas. Some students reflected positively on the point that they did not need to learn about every single aspect of the project. In reality, within the given timeframe, the majority of digital media design students would not have been able to learn and apply the utilised complex IT concepts of the developed interactive media design projects.

The feedback from both students and educators suggests that the POOL Model framework enables and supports learning about the practice of diverse disciplines. The majority of digital media design students stated that they learned to understand and

appreciate other disciplines. While some digital media design students initially felt they were not able to learn about other disciplines (in 2nd year), the majority developed empathy across disciplines when they engaged for the second or third time in multidisciplinary collaborations (in 3rd year).

The reflections from students and educators in terms of challenges are similar. The poor work ethic of some individual team members was the main problem cited, although this is arguably inevitable in any group work environment. Digital media design students also identified communication problems, which in some cases were no doubt linked to less-motivated team members. The biggest difference is that some educators highlighted that there is still a positive learning outcome for students when experiencing challenges in teamwork situations. Ultimately, it is important to acknowledge the identified issues in order to continue to refine the POOL Model framework.

Although a small-scale study, it is notable that the majority of undergraduate digital media design students developed characteristics of a T-shaped designer. The feedback suggest that the majority of digital media design students will be prepared to work in a multidisciplinary collaborative environment in the future as they have begun to develop an understanding of, and appreciation for, other disciplines. The feedback suggests that these undergraduate digital media design students will be able to identify when they need to supplement their own skills with those from other areas. Quantitative and quantitative evidence in support of this achievement came from both students and educators, with the mixed methods approach enabling the advantages of each form of research methodology to emerge and to further triangulate findings.

Further research is needed to explore what strategies can be put in place to reduce challenges experienced by some students in these trials. Furthermore it is important to evaluate student success in the market place once they have graduated. A significant outcome of these trials is the development of a multidisciplinary capstone subject at the Faculty of Law, Business and Creative Arts at the researcher’s institution, which will involve undergraduate students from three schools (Law, Business, Creative Arts), to be implemented in 2014.

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